Small-scale Forestry (2008) 7:387–401
DOI 10.1007/s11842-008-9061-3

RESEARCH PAPER

Nursery Training for Smallholders: An Evaluation of Two Extension Programs in the Philippines

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Accepted: 19 May 2007 / Published online: 8 July 2008

Abstract High-quality seedlings are a prerequisite for successful forestry and agroforestry expansion in developing countries. Unfortunately, in the central Philippines, as supplies of timber from native forest have diminished in recent years, the expansion in planting of timber trees has been retarded by sub-optimal production of seedlings from small-scale nurseries. To address this problem, an extension program supported by the Australian Centre for International Agricultural Research (ACIAR) has attempted to improve the quality of seedlings produced in home nurseries, by assisting smallholders to raise and out-plant seedlings. A complementary program undertaken as part of the Community Agricultural Technology Program (CATP) has attempted to provide community workers and managers of small-scale nurseries with the benefit of recent ACIAR nursery research. Extended assistance in the ACIAR program addressed smallholders' low self-efficacy in nursery technology and was successful in assisting them to grow high quality seedlings. A limited program of assistance was relatively unsuccessful. Evaluation of the CATP program showed that prior to the training, CATP participants were unfamiliar with some aspects of basic nursery technology. Consequently, they may have been unable to provide competent advice to smallholders. This implies that—as with the ACIAR training—extended training and follow-up assistance may be the key to improving the quality of seedlings for forestry and agroforestry expansion in the central Philippines.

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Keywords Mahogany · *Hypsipyla robusta* · Root-trainer pots · QNT seedling trays · Self-efficacy

Introduction

In recent years, the importance of timber supplied from smallholder plantations in the Philippines has increased, concomitant with a decrease in timber supplied from native forests (Bertomeu 2006). Consequently, since the 1970s the Philippines government has introduced a series of forestry support programs and two issues currently addressed by these programs are the provision of assistance to individual smallholders and the development of seedling nurseries (Harrison et al. 2004). However the adoption of small-scale forestry in the Philippines has been slow and has been constrained by smallholders' limited financial resources which restricts their ability to purchase planting materials (Peque 2005), insecure property rights, critical time demands of other farm activities and lack of knowledge about growing trees (Venn et al. 2001).

In addition to the high cost of planting materials for smallholders, the quality of the planting stock produced by most small-scale nurseries in Leyte is sub-optimal. From a survey of 74 small-scale nurseries in Leyte, Gregorio et al. (2004) reported that most of the seedlings produced by the nurseries were etiolated and root deformation was common. They concluded that many of the seedlings produced in these nurseries were unlikely to withstand the adverse conditions of most planting sites. Baynes (2005) also reported that in Leyte seedlings are often grown on the ground in nurseries, which results in root damage when the seedlings are moved.

Paradoxically, although many rural Filipinos are skilled in the art of growing and raising a wide variety of crops, the management of forest nurseries in Leyte is such that tree seedlings are unlikely to achieve their full growth potential. As a response to this problem, two recent extension programs have provided smallholders with technical information and advice to assist the production of high-quality seedlings in small-scale or home nurseries.

The first program (hereafter called the ACIAR program) was undertaken as one of the activities of ACIAR project ASEM/2003/052, *Improving Financial Returns to Smallholder Tree Farmers in the Philippines.* The second program, undertaken under the auspices of CATP, was also supported by ACIAR and was designed to extend technology generated from ACIAR-funded projects and Filipino research providers to community-based organizations. The underlying premise of both programs was that, as stated by Aggangan (2001), the basic technology of growing timber plantations in the Philippines is well understood but needs to be packaged in a form more easily understood by smallholders. Hence, because the capability of the Department of Environment and Natural Resources (DENR) to provide extension assistance to smallholders is strictly limited, one of the focus points of both the ACIAR and the CATP programs has been to offer smallholders access to practical training which would assist this technology transfer.

Because extension programs which depend on the donation of finance or materials are unlikely to achieve long-term improvements to smallholders' wellbeing (Wallace 2006), the primary aim of these programs has been to increase the self-efficacy—that is, a belief of being capable of succeeding in particular certain activities (Sanna 1992)—of smallholders so that that they could grow high-quality seedlings in the future with minimal financial outlay. Hence, both programs were designed to provide hands-on training in nursery seedling production. Material assistance was only offered in the ACIAR program and in that case it was restricted to the supply of mahogany seed and Queensland native tube[1] (QNT) seedling trays.

This paper presents an evaluation of extension assistance delivered to smallholders via two nursery extension programs in Leyte and Bohol provinces. The next sections describe species selection and the nursery technology which was presented to smallholders. Following sections report the conduct and the evaluation of the training. Finally, the implications of the results of these extension programs for further nursery training to smallholders are discussed.

Selection of Tree Species, Appropriate Nursery Technology and Research Aims

Seedling quality and availability is a critical influence on the delivery of forestry and agroforestry extension programs in the Philippines (Herbohn et al. 2001; Carandang et al. 2006). Unavailability of seed precluded using many of the native dipterocarp species for this program because most dipterocarps only produce an abundant seed crop once every 3–5 years and the life span of seeds is short (Smits 1994). Two other native species *Vitex parviflora* and *Pterocarpus indicus* are also highly valued in the Philippines but were not considered because they adopt a multi-branched form in plantations, this growth habit being typical of late-secondary or climax rainforest species such as these, when grown in full sunlight (Evans 1986). It is also usually easier to purchase seed of exotic rather than native species in the Philippines (Tolentino 2005).

The main species initially considered for both programs were *Acacia mangium* (mangium), *Eucalyptus deglupta* (bagras), *Gmelina arborea* (gmelina) and *Swietenia macrophylla* (mahogany), because they have been widely adapted for agroforestry in the Philippines. Carandang et al. (2006) noted the use of the first three species in various parts of the Philippines and Garrity et al. (2002) recorded that the exotic species *Paraserianthes falcataria* (falcata) and *Eucalyptus camaldulensis* were commonly planted in Mindanao. All of these species have disadvantages for use in an extension program. Mangium is not a preferred species in some parts of Leyte and bagras is intolerant of infertile sites. Young bagras seedlings are also prone to fungal infections (Bertomeu and Sungkit 2002) and the form of gmelina is characteristically very poor. *Eucalyptus camaldulensis* has been observed by the authors to be susceptible to wood borers and falcata seed is not readily available in Leyte.

[1] QNT seedling trays were designed by Forestry Plantations Queensland, the corporation responsible for managing government-owned timber plantations in Queensland, Australia.

Mahogany suffers from the tip borer *Hypsipyla robusta* which can cause stem deformities. However, mahogany is a preferred species for small-scale plantations in Leyte. At approximately 15 years, its rotation period is shorter than that of most native species and the market demand for mahogany timber is strong. The over-riding characteristic which made mahogany suitable for both programs was that the seeds are easy to germinate and grow. Mahogany seed is also easily collected because it produces large seed pods which ripen and fall to the ground in February. The seed pods hold up to about 60 winged seed. Bagras and gmelina were selected as alternative species because they both seed prolifically and have a short rotation.

Selection of Appropriate Nursery Technology and Design of the Extension Programs

Nursery procedures are well documented in the literature and similar principles apply for nurseries described by Williamson (1993) for industrial plantations in the Philippines, Howcroft (2002) for balsa nurseries in Papua New Guinea and Doran (1990) for small-scale nurseries in for Australia. For industrial forests, Williamson (1993) suggested a nursery design where seedlings are held in elevated benches in which plastic root-trainer pots are held in mesh steel. According to Crane (1990), the greatest problem with seedlings in containers is that the roots tend to circle around the container's wall and form a dense root-ball. Alternatively, the tap root grows to the bottom of the container and then grows upwards again ('J' rooting). Both the formation of a dense root ball and J rooting cause trees to be stunted by strangulation with their own root systems and increase the likelihood of trees being uprooted by strong winds. 'Root-trainer' pots which have internal vertical ribs which direct the roots downwards have become increasingly popular as a remedy for this problem (Doran 1990).

The advantage of growing seedling in an elevated position is that air circulation underneath the pots causes air pruning of roots which grow out of the base of the pots. Separation of the seedlings by fitting containers into the spaces in steel mesh also reduces the potential transmission of fungal pathogens between adjacent pots. Hence, the higher cost of benches and trainer pots may be offset by reduced incidence of fungal infection and better-formed root systems. For small-scale balsa nurseries in Papua New Guinea where financial constraints preclude the use of root-trainer pots, Howcroft (2002) recommended that seedlings be grown in polybags which are supported and separated by chain wire mesh.

For both the ACIAR and the CATP programs, the review of appropriate nursery technology provided four potential improvements to seedlings grown in Leyte small-scale nurseries. First, elevation of pots or polybags above ground level increases drainage which reduces the incidence of fungal infection and isolates seedlings from predators. Second, separation of pots minimizes transmission of fungal spores or hyphae and third, ventilation of pots (underneath) promotes air pruning of roots which minimizes root damage when seedlings are transplanted. Fourth, out-planting of seedlings before the seedlings become root-bound minimizes the incidence of malformed root systems.

In the ACIAR program, technical advice was provided to smallholders who were likely to have limited formal training in nursery techniques although they were also likely to have some experience of germinating seed and raising plants. Therefore, the four potential improvements were incorporated into the delivery of a nursery extension program with four stages, namely:

1. Introducing smallholders to nursery technology and an overview of timber plantation establishment
2. Collecting, drying and storing seed
3. Preparing potting soil and setting up a home nursery
4. Germinating and growing seedlings.

The ACIAR program had both an extension and a research component. The extension component was to provide volunteer smallholders with training so that they could grow high-quality seedlings and out-plant them before the seedlings became pot bound. The research component of the program was to evaluate how smallholders responded to the challenges and problems of raising seedlings.

The aim of the CATP program was to impart best practices and technology which had been developed from ACIAR-supported research projects. Although the information imparted in the program was broadly aligned to the four potential improvements described above, the clientele was different. Participants were drawn from non-government organizations (NGOs) several of whom had some experience of seedling production and farmers who worked in small-scale community nurseries. Consequently, it was anticipated that the participants would possess widely varying levels of information on the topics addressed. Unlike the ACIAR program, CATP is not research-oriented and it was not intended to undertake follow-up evaluation of the adoption of the technology or to determine constraints to its use. Therefore the evaluation of the program was to ask participants what technology was new to them, and whether the training was of value to them.

Undertaking the ACIAR and CATP Extension Programs

Different strategies were used for the two extension programs. Whereas the ACIAR program invited the participation of volunteer smallholders and provided part of the training on their farms, the CATP program used selected NGO staff and farmers and provided training at a central location.

ACIAR Program, Methods, Results and the Effect of Smallholders' Low Self-efficacy

Volunteer smallholders were recruited from four municipalities, namely Libagon, Dulag, Bato and Leyte Leyte. Assistance was offered in two formats:

1. Smallholders were offered assistance and site visits to their farms at each of the four stages described above. The aim of this extended form of delivery was to provide smallholders with encouragement as well as technical support and to lead

them through the process of establishing a nursery and growing seedlings. The extended format included three additional visits by extension staff to individual smallholders.

2. Assistance was offered up to and including step 3, viz. the preparation of potting soil and setting-up a home nursery. The aim of this restricted form of delivery was to assess whether smallholders would maintain interest in their home nurseries and whether they could cope with problems as they arose.

Between September 2005 and April 2006, smallholders in Libagon and Dulag were offered the extended form of assistance to monitor the progress of their nurseries and to provide advice. The restricted format of assistance was offered to smallholders in Bato and Leyte Leyte between October 2006 and May 2007.

Introduction of Nursery Technology During the Field Days

Smallholders from all four municipalities were taken on a one-day bus trip in which they were shown a range of nursery and plantation management techniques. ACIAR staff demonstrated the preparation of potting medium from soil and rice hulls (3:1 ratio), filling and wetting-up seedling tubes and polybags, sowing mahogany seed, and care of young seedlings. ACIAR staff also demonstrated the undesirable root characteristics of old pot-bound seedlings and the well-formed root systems of younger seedlings. The catch-phrase of 'elevate, separate and ventilate' was used to reinforce the notion of placing seedlings in a position where they were secure from predators, separated to reduce transmission of disease and ventilated to prevent roots growing out through the bottom of the containers. At the conclusion of each field day, participants were invited to join a half-day excursion to collect seed as a precursor to establishing their own home nursery.

QNT seedling trays were selected as a teaching aid with which to illustrate the principles of seedling elevation, separation and ventilation. QNT seedling trays hold 50 individual reusable root-trainer pots with a volume of 220 ml each. Each tray has a clip-on base which elevates the tray above nursery benches and provides airflow underneath. While the trays provide a 'high-technology' approach to growing seedlings, it was suggested to smallholders that a low-cost alternative to QNT trays was to grow seedlings in polybags on a slatted bamboo bench, with slight separation between polybags, so as to maximize airflow.

Seed-Collection Excursions and Setting Up Home Nurseries

Seed-bearing mahogany trees were found in all municipalities except Dulag and smallholders were shown how to select seed pods from trees of superior size and form, how to extract the seed by breaking open the pods and how to dry (in the shade) and store seed in a cool place or a refrigerator. The seed collection excursion was designed both to show smallholders how to collect seed and to show them where seed could be collected in the future. Because mahogany pods have little commercial value, the owners of the mahogany trees indicated that they would permit smallholders to collect pods free of charge, in future years.

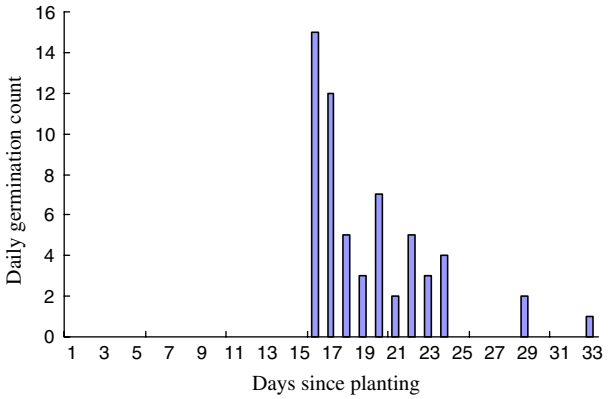

Fig. 1 Typical daily germination count of mahogany seeds

Within about 3 weeks of the seed collection excursion, smallholders were provided with revision instruction of the principles and practice of setting up a home nursery. After arranging for a host farmer in each barangay[2] to prepare fertile friable soil and rice hulls[3], ACIAR staff demonstrated the preparation of potting medium and sowing of seed to the training participants and any interested neighbors. They were also given instructions on seedling production, including watering, protection of young seedlings from heavy rain, shade and sunlight requirements of growing seedlings, protection of seedlings and hardening off. As a gesture of goodwill, each smallholder was given one or two QNT trays.

Germination of mahogany seed in home nurseries occurred after approximately two weeks and continued for approximately another two weeks (Fig. 1). During the germination and initial growth phase of seedlings, ACIAR staff visited each smallholder in Libagon and Dulag three times on their farm to provide encouragement and guidance. On each occasion, staff discussed procedures for hardening-off seedlings and the following steps of plantation establishment. Comparable site visits were not made to smallholders in Leyte Leyte or Bato.

In conjunction with each extension activity, ACIAR staff collected qualitative and quantitative data concerning the number of seedlings raised, seedling mortality and smallholders' verbal expressions of self-efficacy. The data included written 'trip reports', voice records of conversations undertaken with individual farmers and summary statistics of seedling mortality and growth. Extension staff also recorded their subjective perceptions of smallholders' enthusiasm and commitment to program activities.

[2] A barangay is the smallest unit of local government in the Philippines.

[3] Rice hulls are a by-product of winnowing rice. They are freely available in many parts of the central Philippines and are commonly used to absorb water and improve the drainage of potting medium.

Smallholders' Acceptance of Extension Assistance, Seed Collection and Setting-Up of Home Nurseries

Attrition of training participants occurred throughout the program. Of the 52 smallholders who attended the field tours, 40 took up the offer of assistance to establish home nurseries and 32 successfully grew more than 50 seedlings (Table 1). Smallholders gave various reasons for not accepting extension assistance, the most common reason being that they wanted financial assistance or that they were interested in planting trees, but had no available land.

Attendance at all three seed collection excursions was marred by heavy rain which flooded local roads. This prevented some smallholders attending in Bato and Leyte Leyte. In Libagon, the personal support and encouragement of the Municipal Agricultural Officer (MAO) resulted in nine of the 13 interested smallholders attending, whereas in Leyte Leyte only three of nine smallholders attended.

Many farmers showed little knowledge of seed extraction drying and storing. Because the weather in Leyte is usually hot and wet, smallholders were advised to dry the seed under cover and to refrigerate it. Refrigeration of seed proved successful because many farmers in Libagon and Dulag were forced to use reserve seed after losing their initial sowing to fungal attack. It was not possible to test seed viability; however, at least one smallholder in each municipality achieved excellent seed germination, suggesting that the normal maximum viability rate—approximately 90% as reported by Mayhew and Newton (1998)—was approached. One smallholder dried his seed in strong sunlight and reported that the viability was subsequently reduced to approximately 10%.

Demonstrations of preparing potting medium and setting up a home nursery were well attended. Except in Bato, where only six of nine smallholders subsequently successfully established a home nursery, most smallholders who attended this demonstration persisted with their efforts to grow seedlings and eventually grew more than 50 seedlings each. Large differences were evident in the number of seedlings grown by smallholders. For example, two farmers indicated that they preferred to grow seedlings in small numbers so that out-planting and maintenance did not become a burden. Consequently, they only took one QNT tray. However, in the four municipalities, seven smallholders purchased 100 or more extra polybags in

Table 1 Participation in extension activities by smallholders in four municipalities in Leyte

Municipality	Number of farmers				
	Attended field tour	Participated in the program	Attended seed collection	Set up home nursery	Successfully grew more than 50 seedlings
Libagon	16	13	9	13	12
Dulag	11	9	N/A	9	7
Leyte Leyte	14	9	3	9	7
Bato	11	9	7	9	6
Total	52	40	19	40	32

which to raise seedlings and three smallholders took the opportunity to raise approximately 900 extra seedlings each.

Considerable variation was apparent in smallholders' acceptance of advice to protect their seedlings from predation from chickens and rats (Table 2). Overall, while 63% of the smallholders grew seedlings in an elevated position and some smallholders specifically constructed a slatted bamboo table with a shade-cloth covering, other smallholders placed seedling trays and polybags on the ground where these were open to predation by chickens and rats. Mean mortality rate from predation was highest in Libagon (15%) and lowest in Leyte Leyte (3%). Chickens can be seen foraging in many Filipino house yards and whenever seedlings were placed on the ground, they become a ready food source.

Most smallholders prepared potting mix according to the specifications recommended by ACIAR staff. However, some smallholders ignored advice to mix rice hulls into the potting mix and persistent wet weather at the time when the mahogany seed was germinating resulted in 30% seedling mortality in Libagon and 35% mortality in Dulag through fungal infection (Table 2). ACIAR staff reported that potting mix which had been prepared without rice hulls often became compacted which allowed water to pool at the top of the seedling tube or polybag. Mahogany seedlings are susceptible to various fungal infections (Mayhew and Newton 1998), over-watering often being the cause. Hence poor drainage—whether in QNT pots or polybags—allowed the infection to spread. Despite smallholders being advised to throw the infected potting soil away and to wash the pots or polybags before re-sowing seed, or to apply Benlate® fungicide to their seedlings, almost all smallholders initially opted to replace seeds in the infected soil. Eventually, rampant spread of the fungal infection from pot to pot forced them to replace the potting soil, re-sow seed and cover their seedlings from persistent rain. Not one smallholder in Libagon or Dulag opted to control the fungal infections with fungicide. In Leyte Leyte and Bato, the weather during the period of germination and initial growth was drier, obviating the need for fungicide. Desiccation was the principal cause of seedling death, being 27% and 18% for these two municipalities, respectively.

Extension staff also commented that smallholders responded to encouragement as well as technical advice and this appeared to be reflected in the high success rate

Table 2 Seedling mortality due to fungal disease, predation by chickens and rats and dessication

Municipality and no. of smallholders	Mean seedling mortality rate (%)		
	Fungal disease	Predation	Desiccation
Libagon (13)	30	15	0
Dulag (9)	35 ($n = 3$)[a]	12 ($n = 3$)	7 ($n = 3$)
Leyte Leyte (8)	0	3	27
Bato (9)	0	14	18

[a] In the municipality of Dulag, the inspection was carried out when most smallholders' seeds were just germinating. Only three smallholders had seedlings sufficiently advance to see the effect of fungal disease, predation or desiccation

Table 3 Examples of smallholders' verbal expressions which denote low and high self-efficacy in nursery practices

Low self-efficacy	High self-efficacy
I don't know what really happened, the leaves just started to turn yellow in colour.	Yes, the instructions can be read on the box. Benlate? I will let my wife look for that because she will be going to Tacloban tomorrow. In the Agrivet store.
Is that a medicine?	
How about the others, do they have good seedlings?	And so I thought that there is an abnormality here. I separated this one immediately so that it would not affect the others.
So it seems that mine are a failure?	
How many months before these should be transplanted?	Yes, I tried to experiment: they are cuttings from branches and now they have grown already.
This one Ma'am should this be replaced?	I'm removing this one so that it will not affect the others.
What do you mean by hardened Ma'am? Kindly explain.	I am starting to expose the seedlings to the sunlight but they are not yet hardened because there not much sunlight.

of the program and the low abandonment rate of nurseries in Libagon and Dulag where 19 of 22 or 86% of smallholders successfully grew more than 50 seedlings. In Leyte Leyte and Bato by comparison, 13 of 17[4] or 76% of smallholders grew more than 50 seedlings, even though they experienced no fungal problems.

Evidence of Smallholders' Low Self-Efficacy

Evidence of smallholders' self-efficacy was gathered in voice records of their conversations with ACIAR staff. Conversations were conducted in the local dialect (Cebuano), transcribed and translated into English. The conversations were thematically coded for expressions which indicated either satisfaction or disappointment at the progress of their nurseries. Analysis of 15 conversations between smallholders and ACIAR staff in Libagon and Dulag found numerous examples of low self-efficacy in nine conversations (Table 3).

Quantitative evidence of smallholders' low self-efficacy was also reflected in the high percentage of seedling mortality from fungal disease in Libagon and Dulag. It is difficult to assess whether the high percentage of seedlings killed by desiccation in Leyte Leyte and Bato was due to lack of knowledge or lack of care. However, only one smallholder in these municipalities abandoned his nursery and the surviving seedlings in other nurseries were mostly healthy.

Undertaking the CATP Program: Training and Practical Exercises

The CATP program in May 2007 was undertaken on the island of Bohol because this was a central location to which representatives from community organizations and local government units (LGUs) could be invited. The workshop was conducted as a two-day training class on nursery seedling production and agroforestry farm

[4] One farmer died in Leyte Leyte, reducing the number of farmers to 8.

design and establishment. Six groups attended from municipalities in Bohol, Claveria and Cebu, the participants being leaders of community organizations and farmers who worked in LGU nurseries.

The training topics included: small-scale nursery design; seed and seedling collection, processing and handling; seed sowing and transplanting; and seedling maintenance. Participants were given hands-on exercises on the preparation of germination medium, sowing bagras seed (so chosen because the seeds are very small), watering germination trays using sub-irrigation, bagging of wildlings and transplanting seedlings.

At the end of the workshop, a survey was conducted to assess the usefulness of the training to the participants. To reinforce their recollection of events, an outline of the subjects covered in the training was presented on a blackboard and participants were asked to comment on topics or information which they considered was useful to them. They were also asked to comment on the aspects which were new to them and the aspects on which they had prior knowledge.

Results of the Evaluation

While the participants commented that overall the training had been useful to them, several responses indicated that for some participants, their pre-workshop level of expertise was low. For example, one participant commented that he had learnt that polybags needed six drainage holes. Comments of this nature indicated that some participants did not have a coherent understanding or mental model of nursery management, i.e. they were attempting to understand *what* they needed to know rather than having a mental model of *how* and *why* technology could be used to grow healthy seedlings.

Despite most participants having experience of seedling production in community nurseries, several aspects of nursery technology were new to them. Technology which was well understood by the participants included:

- differences between organic and inorganic fertilizer
- hardening of seedlings prior to out-planting and
- grading seedlings for size and health

A majority of the participants had used organic and inorganic fertilizer to improve the growth of seedlings. However, most participants were unaware of several common nursery practices. Technology which was not well understood by the participants included:

- constituent ratios for potting and germination media
- sub-irrigation watering
- sterilization of germination medium
- rate of fertilizer application
- number and position of drainage holes in polybags
- use of fungicides and
- bagging and handling of wildlings.

It was apparent that prior to the workshop, participants who were employed in community nurseries had a limited mental model of nursery management. During the practical exercises, several participants indicated that they had not seen the sub-irrigation method of watering seedlings (i.e. placing germination trays in a container of water) before. Neither did they have a 'recipe' for preparing potting and germination media and none of them had ever bagged wildings.

Implications of the Results of the Programs for Further Training

The ACIAR program provided a contrast between the effectiveness of extended and restricted assistance in enabling smallholders to grow seedlings. One of the key factors in determining the feasibility of small-scale forestry to smallholders in developing countries is the ability to cope with unforeseen problems (Franzel et al. 2002). ACIAR extension staff commented that without their intervention in Dulag and Libagon when wet weather had caused outbreaks of fungal disease, the extension program may have collapsed because most smallholders would have abandoned efforts at growing seedlings. However, encouragement and advice provided sufficient motivation for smallholders to continue their efforts and to raise healthy seedlings. The finding of this program—that technology transfer requires reinforcement through extended training sessions—is supported by the results of other agroforestry extension programs. For example, Kiptot et al. (2006) in Kenya found that seed sharing amongst farmers was easier to promote than technology dissemination and Manurung et al. (2006) in West Java found that farmers hesitated to intensify the management of their tree farming systems because they did not know where and how to focus their efforts.

Congruent with the lack of experience of CATP participants in fungicide use, advice to smallholders in the ACIAR program to use fungicide was universally ignored. This may be either because fungicide was expensive, or because it was a new technology which they did not understand. The inability of smallholders to read and understand directions which are printed in English on packets of fungicide may be a contributing factor. LGU staff commented that growing seedlings in home nurseries was new technology for many smallholders and the smallholders' comments indicating low self-efficacy support that position. Also, not one farmer in the four municipalities applied slow-release or water-soluble fertilizer to the seedlings. This is not surprising because fertilizer which is suitable for nurseries is not readily available in local stores and its use in nurseries appears to be relatively unknown.

ACIAR staff commented that the high percentage of seedlings which died from desiccation at Leyte Leyte and Bato was indicative of a low standard of care. To external observers it was obvious that ACIAR staff had achieved a high degree of rapport with the smallholders in Libagon and Dulag, but that the limited contact with smallholders in Leyte Leyte and Bato had precluded this relationship. Of necessity, smallholders in all four municipalities prioritized their normal farming activities over meetings with ACIAR staff. Consequently in Leyte Leyte and Bato,

some farmers did not meet ACIAR staff for several months even though every effort was made to have meetings with them.

Where smallholders were supplied with extended assistance, the primary aim of the ACIAR program—of assisting volunteer smallholders to grow high-quality seedlings—was achieved. Although many smallholders displayed low self-efficacy through their words or actions, with encouragement and support, they gained confidence during the program. For these smallholders, establishing timber plantations would now appear to be technically feasible, whereas prior to the program it was not. Smallholders who were not supported throughout the entire process neglected their seedlings and incurred unnecessary seedling deaths through desiccation.

This investigation has shown that low self-efficacy of smallholders may require more to overcome than simply the provision of technical advice. Although difficult to quantify, the enthusiasm and rapport which extended assistance generates between extension staff and smallholders may be the key to improving seedling quality in small-scale and home nurseries. These findings mirror the findings of Glendinning et al. (2001) in eastern India that direct contact between extension workers and farmers is a key element in raising participation because as well as making information available, the contact potentially makes the technology desirable, relevant and useful. The 'Landcare' extension process in Claveria in the Philippines also encourages farmers to conduct their own on-farm trials so that they become agents for diffusion of the technology (Mercado et al. 2001) and after approximately 20 years of extension, agroforestry is now widely diffused within the community and has evolved into four distinct tree-based farming systems (Magcale-Macandog et al. 2006).

The CATP training provided a complementary approach to the ACIAR training, participants being selected so that they may learn or reinforce their understanding of the basics of nursery management and transfer this knowledge to their communities. Comments from the CATP participants that much of the technology demonstrated at the workshop was new to them, implies that at present the participants do not constitute a pool of expertise which untrained smallholders can confidently access. The CATP training may have provided an introduction to nursery technology, but further training may be needed to ensure its adoption or implementation. In the same way that it is difficult for smallholders with low self-efficacy to increase their confidence without extended assistance, it may be difficult for these participants to address problems in small nurseries. The training was therefore successful in providing a knowledge base of nursery operations which could be reinforced with further training.

One of the most positive aspects of both the ACIAR and CATP training programs was that these were very well received by the participants, who accepted a relatively top-down delivery style in the interests of time management. On occasion, in Libagon and Dulag the degree of rapport between extension staff and smallholders approached camaraderie. ACIAR staff were invited to share meals and the tenor of conversations was social as well as technical. Participant response in the other municipalities, and for the CATP training was also universally positive. However, the evaluation of both these programs has indicated that there are large gaps in

participants' understanding of basic nursery technology. Consequently, the key to improving the self-efficacy of smallholders and nursery workers may be follow-up training and reinforcement of basic nursery principles.

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